Hydrolyzed Lactose Cultured Dairy Products. II. Manufacture of Yoghurt, Buttermilk and Cottage Cheese

Dana M. Gyuricsek and Marvin P. Thompson
Eastern Regional Research Center[1]
Philadelphia, Pennsylvania 19118

As an approach to improved dairy products and as a potential solution to lactose intolerance, hydrolyzed lactose milks were used in the manufacture of cultured dairy products. It has been observed from preliminary taste evaluations that yoghurt prepared from hydrolyzed lactose milks is preferred over conventional yoghurt. The preference is attributed to the increased sweetness of the new product. Conventional buttermilk, however, is preferred to that prepared from hydrolyzed lactose milk. Cottage cheese manufacture is improved by increased yields (5-12 percent) of curd. This increase is due to less curd shattering during cooking. Preliminary reports of this research have already stimulated commercial interest in these products.

Introduction

In the first paper of this series[6] we described the manufacture of cheddar cheese from hydrolyzed lactose (HL) milks[5]. This paper reports the manufacture of three other commonly consumed cultured dairy products, yoghurt, buttermilk, and cottage cheese[1,7]. In addition to the advantages in the manufacturing of these products described below, hydrolysis of lactose by the enzyme lactase offers the advantage of low lactose products which can be consumed by those intolerant to the sugar[4]. Yoghurt, buttermilk, and, to a lesser extent, cottage cheese are rich in lactose. The advantage of conversion of this sugar to the more simply metabolized glucose is apparent.

Materials and Methods

Milk supply. Commercial skim milk or skim milk prepared by separation of Jersey milk was used for the manufacture of yoghurt, cultured buttermilk, and cottage cheese. Low-heat nonfat dry milk (NDM) was used for the fortification of yoghurt.

Cultures used. All cultures used were standard for the product prepared. Frozen culture concentrates were obtained from Marshall Division of Miles Laboratories* and were rotated according to phage susceptibility to minimize phage contamination. Usually a single transfer was made from the concentrate to the starter media. Consecutive transfers were not made.

Protocol for product manufacture. Yoghurt was prepared from either skim milk or whole milk fortified with 4 percent NDM. *Saccharomyces lactis* lactase, obtained from Enzyme Development Corporation, New York, was added to the fortified mixture at a rate of 0.3 g/l. and reacted for 2-3 hours at 30 C. This ensured at least a 90 percent hydrolysis of lactose as determined by the method of Jasewicz and Wasserman[2]. Following heat treatment at 80 C. for 30 min., the milk was cooled to 45 C. and blended with similarly heated but not enzymatically treated milks to give 0, 25, 50, 75, and >90 percent hydrolyzed lactose milks. A 2.5 percent active starter consisting of equal amounts of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* was added to the milks which were incubated at 45 C. in either a water bath or circulating air incubator. The pH of the incubating mixture was observed hourly until a final pH of 4.6 was reached.

Cultured buttermilk was prepared from fresh skim milk, containing 1 g NaCl/1. to which .3 g lactase was added per 1. and reacted at 30 C. for 2-3 hours. The milk was pasteurized at 85 C. for 30 min., cooled to 22 C., and inculated with 0.5% lactic culture. After 14-16 hours, pH of the curd had reached 4.5.

Large curd cottage cheese, which was manufactured by the short set method, usually took 4-5 hours to reach pH 4.6. The rate of acid development was controlled by varying the percent of lactic starter added to between 5 and 6 percent. On laboratory size vats (22.7 l. milk), 0.3 g lactase/1., mixed with an equal amount of sucrose to aid dispersion, was added to the cold milk. Upon warming to setting temperature, the enzyme was completely dispersed. No attempt was made to heat-inactivate the lactase; however, pH's below 5.5 inactive the enzyme irreversibly. In commercial operations (11,364 kg milk), lactase (0.1 g/1. or 1.16 kg/vat) was mixed with sucrose and added to the silo at 4-5 C. with constant agitation. Dispersion was complete within 1 hour, and the milk was reacted for 16-18 hours and subsequently pasteurized at 71 C. for 15 sec. Active lactic cultures were added at a rate of 5-6 percent. Usually the curd was cut at pH 4.7-4.6 depending upon its strength and cooked to a final temperature of 47.7-51.7 C. Curd was dressed according to usual methods.

*Reference to brand or firm name does not constitute endorsement by the U.S. Department of Agriculture over others of a similar nature not mentioned.

Results and Discussion

The advantages, improvements, and other considerations that are suggested by the hydrolysis of lactose in yoghurt, buttermilk, and cottage cheese are as follows: (a) The time required to reach desired pH values in the manufacture of yoghurt and cottage cheese is reduced by 40 min. and 135 min. respectively (Figs. 1 and 2). Similarly, the time required to coagulate buttermilk is reduced. The saving in man-hours with the former can be regarded as significant. (b) Usually, the high acid flavor of yoghurt and cultured buttermilk (and to a lesser extent, cottage cheese) is partially off-set by the sweetness imparted by glucose. In comparative evaluation with plain yoghurt, HL yoghurt was preferred, whereas the sweetness in HL buttermilk proved to be objectionable. HL yoghurt was smoother in body than was its control. Increased sweetness in cottage cheese curd is off-set by the fact that the curd is ordinarily dressed, thereby masking the sweetness. (c) In the manufacture of cottage cheese from HL milks, increased yields of curd ranging from 5-12 percent were common. For example, in a

[1]Agricultural Research Service, U.S. Department of Agriculture.

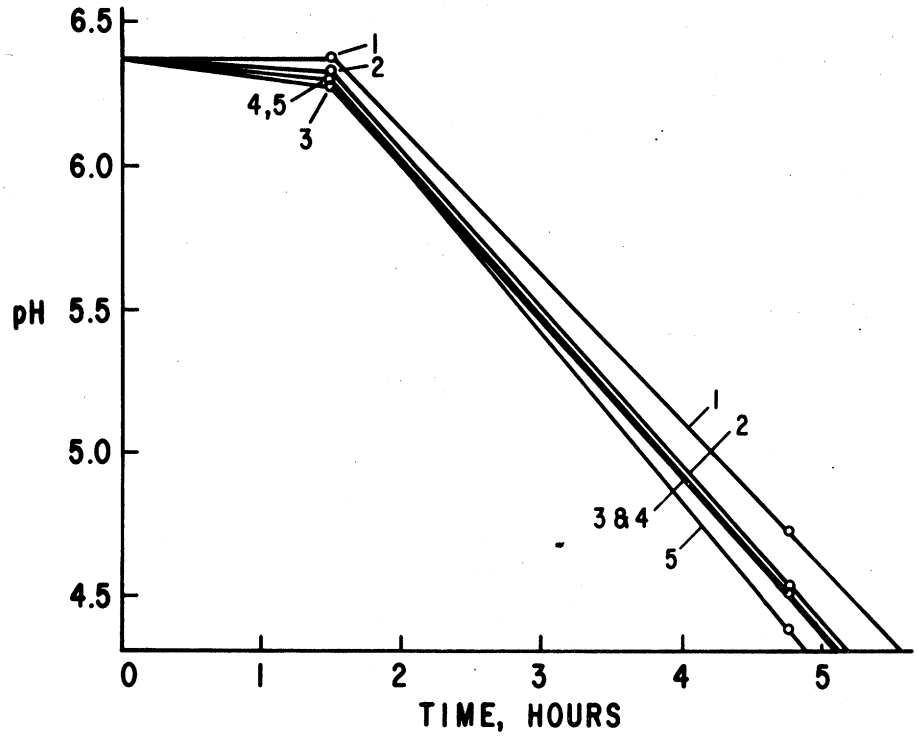

Fig. 1. Acid development in the manufacture of yoghurt (45 C.) as a function of time for (1) 0, (2) 25, (3) 50, (4) 75, and (5) >90 percent hydrolyzed lactose milks.

particular commercial large curd cottage cheese operation, low yields of curd due to shattering were common. Corrective measurements such as cutting of curd at different pH values, addition of nonfat dry milk, addition of salts, and variations of setting temperatures failed to correct the problem. Application of hydrolyzed lactose milks had the following effects. A control vat of large curd yielded 1,614 kg from 11,364 kg skim milk. a vat of HL milk yielded 1,841 kg. While identical in moisture, the increased yield arose from the fact that curd shattering was greatly minimized; the resulting curd had an excellent appearance. This vat of HL cottage cheese dressed to 2,727 kg. From practical and economic considerations (cost of enzyme), we would suggest that other corrective methods for maximizing yield of cheese be practiced. In the event of their failure, HL milks could be used successfully. (d) While the magnitude of lactose intolerance cannot be completely assessed, it is clear that particular ethnic and racial groups exhibit the syndrome. The consumption of hydrolyzed lactose cultured dairy products in such foods as yoghurt, buttermilk, and cottage cheese would reduce the lactose intolerant reaction, improve the overall nutrition of the consumer, and could result in increased sales of the products[3]. (e) Whey obtained as a result of hydrolysis of lactose, whether it be acid or sweet whey (cheddar, blue, Mozzarella, etc.), can be concentrated to 70 percent solids. This concentrate, with increased sweetness, can be used in the manufacture of ice cream without lactose crystallization. Acid cottage cheese whey, of course, does not lend itself as favorably to this application.

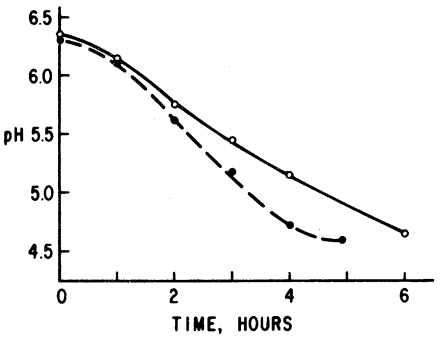

Fig. 2. Acid development in the manufacture of cottage cheese (30 C.) as a function of time for control milk (solid line) and >90 percent hydrolyzed lactose skimmilk (dashed line).

References

1. Gyuricsek, D.M., and M. P. Thompson. Preparation of fermented dairy products from hydrolyzed lactose milk. American Chemical Society, Ninth Middle Atlantic Meeting., April 23-26, 1974., Wilkes-Barre, Pa. Program and Abstracts, Abstract 141 (p. 45).
2. Jasewicz, L., and A.E. Wasserman. 1961. Quantitative determination of lactose. *J. Dairy Sci.* 44:393.
3. Paige, D.F. Private communication.
4. Rosensweig, N.S. 1969. Adult human milk intolerance and intestinal lactase deficiency. A review. *J. Dairy Sci.* 52:585.
5. Thompson, M.P. and D.P. Brower. 1974. Manufacture of Cheddar cheese from hydrolyzed lactose milks. *J. Dairy Sci.* 57:598.
6. Thompson, M.P., and D.P. Brower. 1976. Hydrolyzed lactose cultured dairy products. I. Manufacture of Cheddar cheese. *Cultured Dairy Prod. J.* 11(1):22.
7. Thompson, M.P., and D.M. Gyuricsek. 1974. Manufacture of yogurt, buttermilk, and cottage cheese from hydrolyzed lactose milks. *J. Dairy Sci.* 57:584.

Journal of Food Protection to be Published in 1977

The first issue of the *Journal of Food Protection* will appear in January, 1977. This international monthly journal in the English language will publish research and review papers on all topics in food science and on the food aspects of the animal (dairy, poultry, meat, seafood) and plant (cereals, fruits, vegetables) sciences.

Major emphasis of the journal will be on: (a) cause and control of all forms (chemical, microbial, natural toxicants) of foodborne illness, (b) contamination (chemical, microbial, insects, rodents, etc.) and its control in raw foods and in foods during processing, distribution, and preparing and serving to consumers, (c) causes of food spoilage and its control through processing (low temperatures, high temperatures, preservatives, drying, fermentation, etc.) (d) food quality and chemical, microbiological and physical methods to measure the various attributes of food quality, (e) the food service industry, and (f) wastes from the food industry and means to utilize or treat the wastes.

The *Journal of Food Protection* is published by the International Association of Milk, Food, and Environmental Sanitarians. The new journal replaces the *Journal of Milk and Food Technology* that was published for 39 years by the same association.

Inquires about manuscripts for publication should be addressed to the Editor, Dr. Elmer H. Marth, Department of Food Science, University of Wisconsin, Madison, Wisconsin 53706, U.S.A. Information about subscriptions and advertising can be obtained from the Managing Editor, Earl O. Wright, P.O. Box 701, Ames, Iowa 50010, U.S.A.